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Sizing and Buying a Wood Stove

R. Topielec, T. Wykes, and L. Giardina

Before you buy a wood stove for your home, make sure you know the size and type of stove that best suits your house and your heating requirements. Don't buy a stove based simply on an advertiser's claims about how big an area it will heat.

The selection of a wood stove should be based on your home's size and interior layout, on how well it is weatherized, and on how cold your winters are. Understanding these heating requirements will help you avoid buying a wood stove that is either too large or too small for your home.

A properly sized wood stove will save you money and provide the best performance. But getting a stove that is too big is worse than getting a stove that is too small.

If you already have a wood stove that is more than 5 years old, it probably doesn't burn as cleanly and efficiently as the new *certified* stoves for sale today. Certified means that a stove has been tested for its operational characteristics and meets Federal Environmental Protection Agency (EPA) air emissions standards.

All stoves sold and installed in Oregon must be certified. A list of certified stoves is available from many stove dealers or from the Oregon Department of Environmental Quality (1-800-452-4011). The list tells you stove types, average smoke emissions and efficiencies, heat output ranges, and burn times (how long a fuel load burns).

This publication will help you size and choose the right wood stove for your home.

Stove Performance and Labeling

A *properly sized* wood stove matches the heating needs of your home, generally operates more efficiently, and emits fewer pollutants. Before you buy, check performance data for any wood stove you are considering. New stoves display two certification labels indicating they've been tested and meet EPA emission control standards:

- A permanently attached label, usually displayed on back of the stove, indicates it has met EPA emissions standards. This label also shows the date of the stove's manufacture, where it was tested for safety, and installation instructions.
- A removable *show room* label, attached to the top or front of the stove, describes the stove's emissions range, efficiency range, and heat output range.

Figure 1 illustrates the two types of labels found on new stoves. The removable label indicates that this particular stove's emissions vary from a little over 1 to about 3½ grams per hour over the stove's heat output range. The label also shows that typical efficiency for this type of stove ranges from about 60 to 67 percent, and lists a delivered heat output range between 11,900 and 43,200 Btu per hour.

Older certified stoves should have labels with similar information but in different form.

Richard Topielec, Extension agent, Union County; Tom Wykes, Extension agent, Deschutes County; and Larry Giardina, Extension agent, Jackson County; Oregon State University.

This publication explains how to size a wood stove for your home. It helps you choose among three types of wood stoves: non-catalytic, catalytic, and pellet. And it tells how other space heating options compare to wood stoves.

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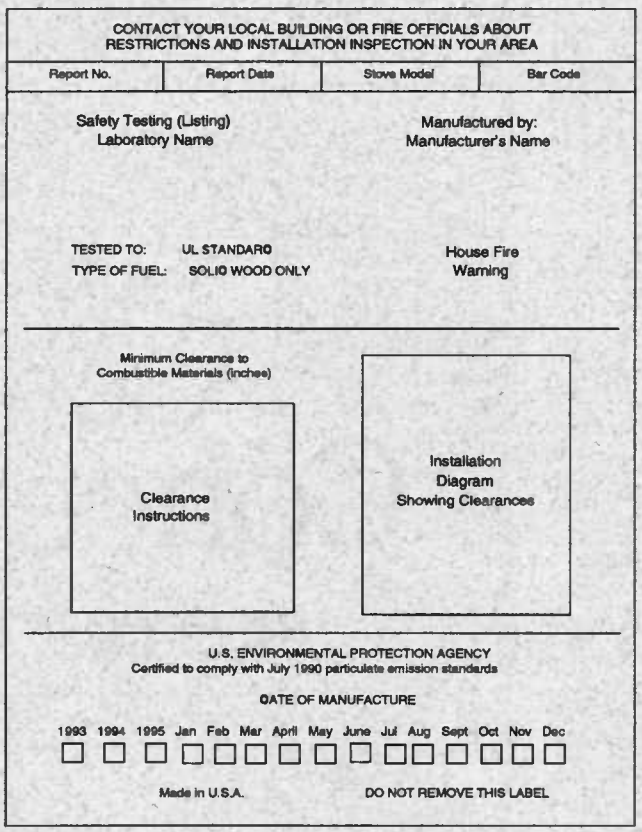
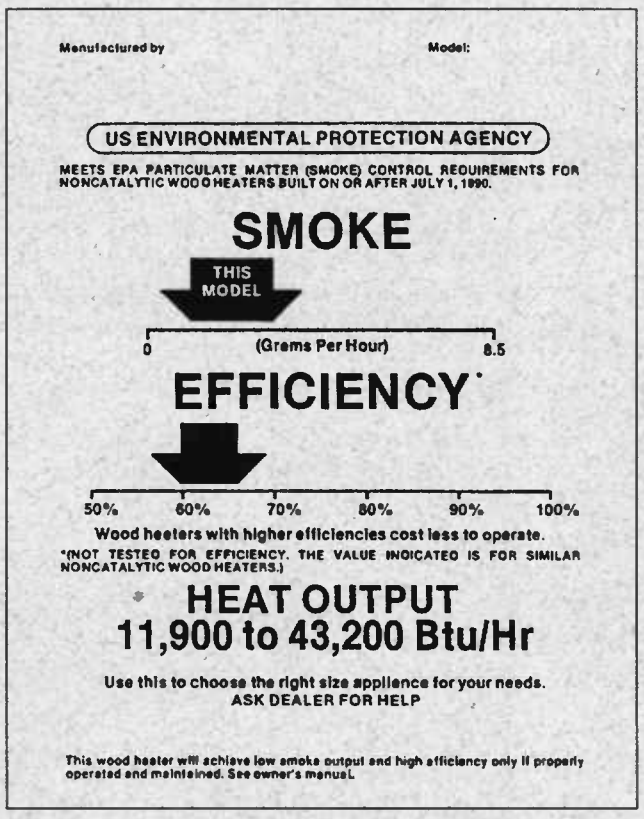
Figure 1.—*Permanent (top) and removable (bottom) labels.*





Sizing Your Wood Stove

Wood stoves are *space heaters*. This means they are limited in their ability to move heated air around walls and over long distances. However, a wood stove can heat larger areas of your house if you use a fan to move heated air. You also can heat rooms above the stove if you have floor registers or stairwells to move air to and from the space.

Try to determine as closely as you can how big an area of your house you can actually heat with a wood stove.

Step 1
Estimate floor area

Basically, a stove placed in one room will heat adjacent rooms if air flow is unobstructed at both the ceiling and floor. This can be accomplished with vents large enough to permit natural air movement, with vents and fans to mechanically move the air, or simply (but much less effectively) through an open doorway. Evaluate your home's floor plan to determine which rooms you can actually heat with a wood stove and determine the area in square feet.

Step 2
Select weatherization level

There are five basic weatherization levels:

Poor—No wall, ceiling or floor insulation; single-pane windows.

Fair—3½ inches of insulation in walls, 6 inches of insulation in ceiling, no floor insulation; single-pane windows.

Average—3½ inches of insulation in walls, 6 inches of insulation in ceiling, 6 inches of floor insulation; double-pane windows.

Good—6 inches of insulation in walls, 12 inches of insulation in ceiling, 6 inches of floor insulation; double-pane windows.

High—6 inches of insulation in walls plus exterior wallboard insulation, 12 inches of insulation in ceiling, 8 inches of floor insulation; double-pane windows.

If your home falls between two levels, choose the lesser of the two.

Step 3
Determine average and maximum heat outputs

Use Figure 2 to determine your stove's average and maximum heat outputs. Locate square feet to be heated and read *across* to weatherization level of your home. Read *down* to "average" and "extreme" winter conditions for your area then *left* to the stove heat outputs in Btu per hour. These values estimate the range of the stove's output necessary to heat the home during average and extreme winter conditions.

Step 4
Compare your results with performance data

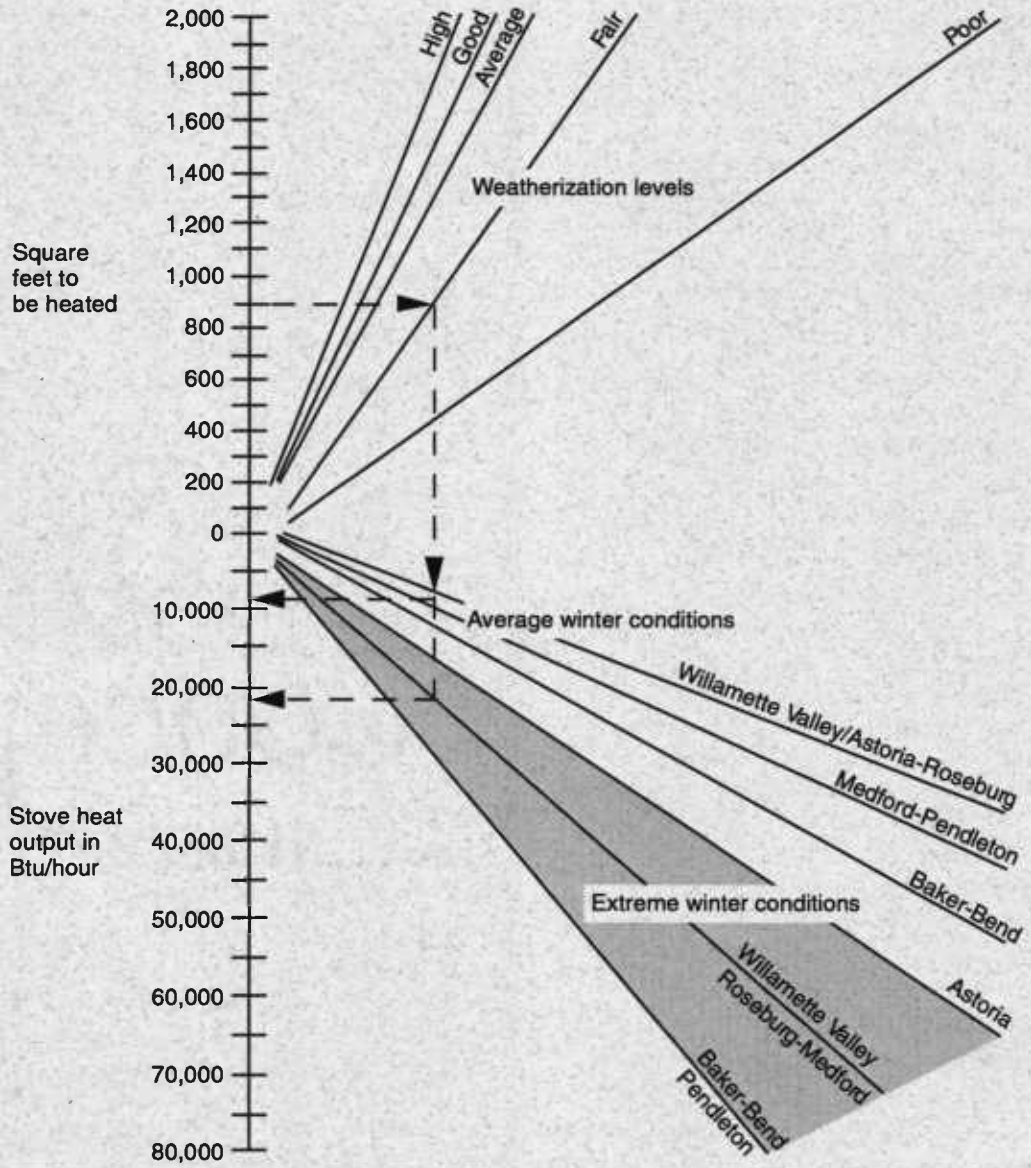
A properly sized wood stove should be capable of supplying the heat output needed for typical winter conditions of your locale. The stove also must have sufficient capacity to supply needed heat during the coldest periods of the year. Select a stove with a heat output range from 20 percent below what's needed for average winter conditions to what's needed for extreme winter conditions.

The stove also should have a burn-time between refueling that meets your expected use. For example, if you like to hold a fire overnight, select a stove that the Oregon DEQ lists as having at least an 8-hour burn-time at low burn rates.

You may choose to use your conventional heating system as backup on very cold days. If so, your wood stove could provide less than the maximum heat output determined from the graph.

Note: Stove performance data are based on uniform test conditions. Your home's actual conditions may require a wider range of heat outputs, depending on the type of wood you use and the way you install and operate your stove.

Figure 2.—*Wood stove sizing graph based on a single story, 1,800 square foot house with window area 15 percent of floor area.*



Stove Sizing Example

A 1,400 square foot home in Eugene will be partially heated by a wood stove. The floor plan lends itself to heating 900 square feet of floor space. The homeowner has decided that the wood stove should be able to heat the space on the coldest day of the year.

The home has double-pane windows, no insulation in the floor, 3½ inches in the walls, and 6 inches in the ceiling.

Follow the four steps outlined in the previous section to determine characteristics of a properly sized wood stove.

Step 1

We need to heat 900 square feet.

Step 2

Although this home has double-pane windows, its weatherization level is closest to the "fair" level.

Step 3

Locate 900 square feet on Figure 2 and read *across* to the "fair" weatherization level. Read *down* to "average" winter conditions in the Willamette Valley, then *left* to a stove heat output of 9,000 Btu/hour. This value is an estimate of the stove's output necessary to heat the home during average winter conditions.

As the weather gets colder, the stove should have the capacity to meet the increased heating requirements of the home. To determine the necessary maximum heat output of the stove, extend the line from the "average" *down* to the "extreme" winter conditions line for the Willamette Valley. Now read *across* to 22,000 Btu/hour.

Step 4

In this example, the heat output needed for average winter conditions is 9,000 Btu/hour and about 22,000 Btu/hour for extremely cold days. The buyer should look for a wood stove that shows on its EPA certification label a heat output range from 20 percent below what's needed for average winter conditions to what's needed for extreme winter conditions: 7,200 to 22,000 Btu/hour.

Buying Your Certified Wood Stove

Certified wood stoves are designed to meet new EPA emissions standards. They incorporate design features that reduce smoke emissions and increase operating efficiencies well above the older non-certified types. Typical efficiencies of certified wood stoves are 65 to 80 percent, well above the 40 to 50 percent efficiencies of the 1970s and early 1980s.

Three types of wood stoves are considered in this publication: non-catalytic, catalytic, and pellet. Non-catalytic and catalytic stoves are in the state certification program. Pellet stoves are exempt from wood stove certification regulations because they operate differently and more readily achieve high efficiency and low emissions. These three types are discussed in detail below.

Compare labels

The labels displayed on new stoves for sale help you compare performances of various models. They contain information on heat output, efficiency, and smoke emissions. A stove's actual performance in your home depends on operating conditions. Take the time to go through the sizing exercise described in this publication. Then select the type of stove from the categories below that best fits your pocketbook and satisfies your heating needs.

Non-catalytic wood stoves

Non-catalytic wood stoves probably are the type of stove most people are familiar with (Figure 3). These stoves consist of a firebox, air controls, and baffles to contain and recirculate combustible gases for efficient combustion. Their design features allow them to achieve low emissions and high efficiencies if properly operated.

Take the time to go through the sizing exercise described in this publication. Then select the type of stove that best fits your pocketbook and satisfies your heating needs.

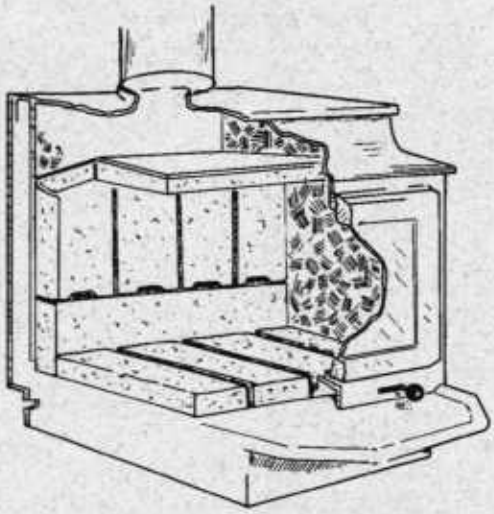


Figure 3.—*Non-catalytic wood stove.*

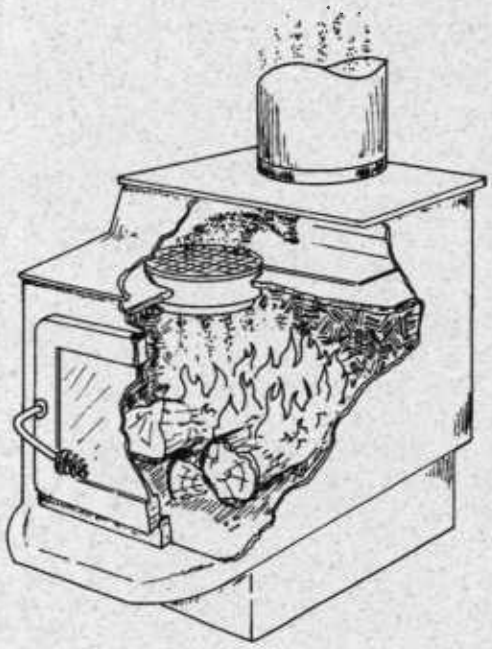


Figure 4.—*Catalytic wood stove.*

Primary combustion air entering these stoves is preheated to keep combustion temperatures high for more complete burning. The more complete the combustion, the more heat is extracted from the fuel and the less unburned gas is emitted in the form of pollution.

Proper operation is critical for combustor life. Failure to ignite gases at the combustor or burning anything other than untreated wood can ruin it.

Baffles are metal plates positioned inside the stove that form barriers to the early escape of unburned combustible gases. The baffles keep combustible gases in the primary combustion zone for as long as possible, then route the unburned gases to the secondary combustion zones. Preheated secondary air also is introduced into secondary combustion zones to ensure re-ignition of combustion gases.

Fireboxes generally are small to encourage the user to burn hotter fires. They often are insulated or contain firebricks to maintain high temperatures in the combustion zones. The air inlets usually have stops that prevent them from being completely closed. This feature ensures adequate air for combustion but shortens the burn time between refueling.

Catalytic wood stoves

Catalytic wood stoves (Figure 4) use a specially treated smoke combustion unit to achieve high efficiencies and low emissions. Properly operated catalytic stoves achieve nearly complete combustion. Catalytic stoves have large fireboxes, air controls, and can be operated at low burn rates for long burns between refueling.

Catalytic stoves contain a ceramic, honeycomb-shaped combustor typically placed in a baffle plate out of direct contact with flames. The combustor is coated with a chemical catalyst (platinum or palladium) that promotes ignition of gases at lower temperatures (350-600°F).

Fires are started with dampers or other mechanisms disengaging the combustor unit and diverting smoke around it. Once the fire is hot enough for gases to ignite with the combustor's surface coating (350-600°F), the combustor is engaged and smoke is directed through it. Many catalytic stoves introduce preheated secondary air at the combustor to supply adequate oxygen for combustion.

Proper operation is critical for combustor life. Failure to ignite gases at the combustor or burning anything other than untreated wood can ruin it. Exposure to temperatures above 1,600°F also will damage the combustor.

Catalytic wood stoves cost about $200 to $300 more than non-catalytic stoves. Combustor units sold in Oregon must have at least a 2-year warranty. They cost from $100 to $200 to replace. Follow the manufacturer's recommendations for combustion unit cleaning and maintenance to extend its useful life under differing conditions.

Pellet stoves

Pellet stoves (Figure 5) burn wood pellets manufactured from wood waste. Pellets are loaded into a hopper where a motorized auger, controlled by a dial or thermostat, moves the pellets into a small burner in the firebox. Combustion air is blown or sucked into the firebox by fans that also exhaust unburned combustion gases through a small diameter stovepipe. Before being exhausted to the outside, the hot gases pass through a heat exchanger. Another fan blows air across the heat exchanger, warming air on its way into the house.

Pellet stoves require electricity to operate fans and augers, so they can't provide heat during power outages (unless they have a battery or generator backup system). The electric motor consumes about 150 watts of power and is part of the expense of operation.

Wood pellets must be purchased but are clean and easy to handle and store. Pellets are readily available throughout the state. Prices vary depending on location.

Pellet stoves are more expensive to buy and operate than other types of wood stoves. But they usually don't require as expensive a chimney system. Pellet stoves have much better controlled air-to-fuel ratios than other stove types and achieve nearly complete combustion. In addition, their heat transfer is excellent. These features rank them as generally the highest in efficiency and lowest in smoke emissions among stove types.

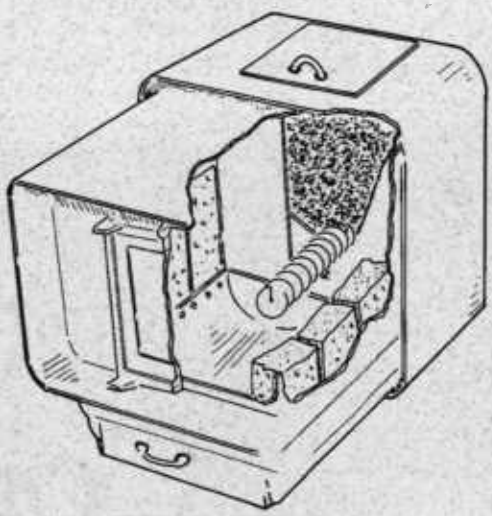


Figure 5.—*Pellet stove.*

Pellet stoves have much better controlled air-to-fuel ratios than other stove types and achieve nearly complete combustion. In addition, their heat transfer is excellent. These features rank them as generally the highest in efficiency and lowest in smoke emissions among stove types.

Other Things to Consider

No matter which wood stove you choose, provide a direct connection of outside combustion air to the firebox. This will reduce the potential for polluting the air inside your home. It also will reduce the amount of warm indoor air drawn through your wood stove and sent out the chimney, so you eliminate a major source of heat loss.

If you live in an area classified as non-attainment, that is, an area that is more susceptible to lingering air pollutants and has difficulty achieving EPA air quality standards, be sure to find out if there are any restrictions or regulations that may influence your stove buying decision.

Other Space Heating Options

A wood stove is not the only space heating option available. Figure 6 shows how some others compare.

Note: Unvented kerosene heaters are not permitted for home use.

Heater Type	Fuel Type	Heating Cost per MBtu	Impact on Environment	Advantages	Disadvantages
Uncertified wood stove; 40-50% efficient	Cut or purchase firewood	$7.04 @ $70.00/cord; $10.89 @ $75.00/cord	Highest emissions of available options	Costs less than a certified stove	Must reload every 2-3 hr; installation is against the law
Certified non-catalytic wood stove; 60% or more efficient	Cut or purchase firewood	$6.40 @ $70.00/cord; $9.90 @ $75.00/cord	Emissions one-third lower than uncertified wood stove	High efficiency means more heat from less wood; low emissions	Small firebox
Certified catalytic wood stove; 60% or more efficient	Cut or purchase firewood	$6.40 @ $70.00/cord; $9.90 @ $75.00/cord	Emissions one-third lower than uncertified wood stove	High efficiency means more heat from less wood; low emissions	Must replace catalytic combustor; small firebox
Pellet stove; 80% or more efficient	Must purchase pellets	$10.00 @ $125.00/ton; $12.00 @ $150.00/ton	Very low emissions; burns wood waste	Thermostatically controlled	Requires small, through-the-wall vent or chimney; doesn't work during power failure
Electric space heater; 100% efficient	Purchased	$11.70 @ $0.04/kWh; $17.60 @ $0.06/kWh	Pollution occurs at the power plant and not locally	No venting required; good for periodic use; thermostatically controlled	Doesn't work during power failure
Natural gas insert/space heater; 70% or more efficient	Purchased	$6.40 @ $0.45/therm; $8.60 @ $0.60/therm	Very clean burning	Some work during power failure; thermostatically controlled	Requires small, through-the-wall vent or chimney

Figure 6.—*Space heater comparison chart.*

U.S. Department of Energy provided funding for this publication. The space heater comparison chart (Figure 6) is by David Brook, Extension agent, Multnomah County, Oregon State University.

The Oregon State University Extension Service educates Oregonians by delivering research-based objective information to help them solve problems, develop leadership, and manage resources wisely.

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